

# Science and Technology Parks and Regional Contextual Factors: A Systematic Literature Review preliminary study

**Poonjan, Amonpat; Tanner, Anne Nygaard**

*Publication date:*
2018

*Document Version*
Peer reviewed version

**Manuscript Submission**
Eu-SPRI Early Career Researcher Conference (ECC) - "Public R&D funding and evaluation: Methods, Trends and Changes"

# Science and Technology Parks and Regional Contextual Factors: A Systematic Literature Review

Amonpat Poonjan
Department of Management Engineering,
Denmark Technical University

Anne Nygaard Tanner
Department of Management Engineering,
Denmark Technical University

Submitted: Sunday 2nd September, 2018

*Abstract:*

Literature on science and technology parks (STPs) lack a systematic understanding of how regional contextual factors affect the performance of STPs. The performance of STPs are continuously questioned and much empirical research fail to show consistent, positive impact of STPs on on-park firms or regional economy in general. Explanations are often sought internal to the STPs resulting in a gap in literature on the role of the regional context for STPs' performance. This paper presents an exploratory, systematic literature review on the impact of regional contextual factors on the performance of STPs

## Introduction

Science and technology parks (STPs) have gained great academic and political interest for their potentials to deliver high-tech innovations and entrepreneurial activities benefitting regional economic development. STPs are thus a commonly used innovation policy tool, implemented to stimulate regional economic development. The number of STPs have increased and continue to grow rapidly. According to the latest data from UNESCO (UNESCO, 2016), there are at least 400 science parks around the world.

However, the performance of STPs has always been questioned. Empirical studies have demonstrated inconsistent results on STPs performance. While some studies have found positive results on firms located in STPs. (e.g. Squicciarini, 2008, 2009; Yang, Motohashi, & Chen, 2009) others have not been able to confirm a positive, significant relationship (e.g.(Colombo & Delmastro, 2002; Lofsten & Lindelöf, 2002; Siegel et al., 2003; Westhead, 1997) and have questioned the effects of STPs on technological development, innovation, regional economic development etc.

The unclear contribution of STPs has led scholars to research factors and mechanism that influence the performance capacity of STPs. However, most research have focussed on internal factors of STPs to explain the inconsistency of their effects (e.g. Colombo & Delmastro, 2002; Ferguson, 2004; Lindelöf & Löfsten, 2003, 2004; Westhead, 1997) and less attention have been paid to external factors. The key internal, explanatory factors point to the importance of the science park management, availability of qualified research and development personnel, marketing expertise, financial support as well as the park identity and brand (Cabral & Dahab, 1998; Colombo & Delmastro, 2002; Lindelöf & Löfsten, 2002; McCarthy, Silvestre, von Nordenflycht, & Breznitz, 2018).

More recently the inconsistency in the literature on STP performance have caused a stronger focus on external, contextual factors for STPs' ability to foster regional development (Etzkowitz & Zhou, 2018; Minguillo, Tijssen, & Thelwall, 2015; Phan, Siegel, & Wright, 2005). Minguillo, Tijssen and Thelwall (2015, p. 712) argue that the external environment of STPs, such as "the agglomeration of the critical mass of knowledge and capabilities" are more relevant for understanding the performance capacity of STPs. Likewise, Tsamis (Tsamis, 2009) find that science and technology parks in less favoured regions in Southern Europe remain primarily real-estate projects with only marginal contribution to the regional technological development and poor records of creating new technology based firms (NTBFs). Tsamis argue that the explanations are to be found within the regional contextual factors, such as pre-existing weak local technological base and the absence of sophisticated demand for the STPs services and mechanisms. Moreover, Etzkowitz, H., and Zhou, C. (2018) provide an example from the successful STPs in the USA and China, which highlights that the innovation dynamic did not induce from the park itself but the interaction between University-Industry –Government interactions shaped by the regional context.

This new interest in regional contextual factors are inspired by the literature on regional studies, which emphasise that regions offer an important source of competitive advantage (Starr & Saxenian, 1995). Therefore it is also reasonable to believe that the success of STPs, as an innovation bridging organisation, are influenced by regional characteristics, such as institutional settings, pre-existing industry, knowledge base and entrepreneurial culture. Although we argue for a greater attention to contextual factors we do not wish to neglect the role of internal park factors in understanding dynamics of STPs.

Literature on the linkages between the performance of STPs and the regional context have been scarce (Goldstein & Luger, 1990; Mora-Valentín, Ortiz-de-Urbina-Criado, & Nájera-Sánchez, 2018). This paper fills this gap by conducting an exploratory, systematic literature review of the relationship between STPs' performance and the regional context. Empirically we identify 451 journal papers in WoS from 2000-2018 that concerns the performance of STPs. Based on a systematic screening process we reduce the initial sample to a group of 64 papers which concerns the interrelationship between 'Science Parks, technology parks or research parks', 'their performance' and 'the regional context'. The exploratory nature of the review aims to capture, in an open-ended coding process, the regional contextual factors that according to the literature play an important role in supporting or hindering the development of STPs and the capacity to promote technological development, NTBFs or regional development.

The results shed new light on the regional contextual factors that contribute to a better understanding of the performance capacity of STPs. These findings are important for the design and use of STPs in future regional innovation policies. We believe that taking the regional contextual factors into consideration in setting up science parks in the future will benefit from this understanding. As such, these findings correspond with the EU Smart Specialisation policy and also to the broad thinking of evolutionary economic geography.

The paper is structured as follows. Next section situate the concept of science and technology parks, in the field of regional studies by focusing on the regional context of STPs. The third section presents the method of the systematic literature review. The fourth and fifth section presents and discusses the findings of the literature review, respectively. The final section highlights the main conclusions and suggests further research.

## Conceptual Framing

### Science and technology parks

The first concept of science park began with Silicon Valley which established in 1951 at the Stanford University (Nahm, 2000; Pascoal & Cabrita, 2016). This idea ignited a rapid growth of science parks across the world and counts today at least 400 science parks around the world (UNESCO, 2017). Literature present that there is no clearly define on STP characteristics, the parks are diverse depending on the host country, level of regional development, the park's objectives, sponsorships and the overall scale of the project. (Amirahmadi & Saff, 1993; Hansson, Husted, & Vestergaard, 2005; Nahm, 2000; Quintas, Wield, & Massey, 1992). This would be one of the major reason that makes STPs' performance is difficult to assess.

However, as we derived from the literature, the *commonly mentioned characteristics of science parks concerns facilitating R&D based technological activities, linking and supporting technology transfer between the academic institution and the park tenants including the attraction and growth of new firms by bringing scientific research, governmental organisations and their business support together in one physical location* (Albahari, Pérez-Canto, & Landoni, 2010; Henriques, Sobreiro, & Kimura, 2018; Hobbs, Link, & Scott, 2017).

Henriques et al., (2018) summarise the literature on STP and regional development as the most controversial topics in the literature. They analysed 56 articles on STP. They found 24 articles discussed on the impact of STP and regional development and the majority of them present that STP has a positive impact on the region, while the rest show that STP has lower than expected impact on the region and only a few with no significant impact on the region. They highlight that in many cases, STP contributes to the region but not with the intensity that stakeholders would expect.

The study from Appold, (2004) Minguillo et al., (2015) and Tsamis, (2009) shown that STP found successful in the competitive region. We would like to shed the light on this unclear topic, how regional milieu affects the on STPs' performance.

### STPs and performance evaluation

How is STP's performance defined? At the most basic level, STP's performance should be defined by their mission accomplishment. The problem is that, past studies have found, parks are diverse characteristics and their mission was defined as generic statement (Bigliardi, Dormio, Nosella, & Petroni, 2006). The wide variety of STP models indicate to different goals and missions. Hence, there is no one line to measure the park performance.

Empirical studies show that the level of STPs performance analysis can be categorised in to four levels (Diez-Vial & Fernández-Olmos, 2017; Martínez-Cañas, Sáez-Martínez, & Ruiz-Palomino, 2012):

(1) the park,
(2) the firms that located on parks,
(3) entrepreneurs involved with these firms and
(4) the systematic or aggregate level

Furthermore, the evaluation indicators are also varied. Literature show that the evaluation indicators can be categorised into two groups; *the financial criteria* e.g. level and type of investments made, turnover generated by the growth of the services provided by the start-up and the development of companies within the Parks,

returns on investments, etc. and *the innovation-related indicators* e.g. number of start-ups, number of registered patents, number and type of new products launched by incubated firms, etc. (Bigliardi et al., 2006; Lamperti, Mavilia, & Castellini, 2015; Zeng, Xie, & Tam, 2010).

Most of the empirical studies strategies have been investigated to measure the performance of STP, these studies attempted to answer the question that whether SPs have been actually successful in promoting innovation, high skill activities, economic performances among the resident firms and linkage between on park firms and HEI (e.g. (Colombo & Delmastro, 2002; Fukugawa, 2006; Link & Scott, 2003; Lofsten & Lindelof, 2001; Lofsten & Lindelöf, 2002; Squicciarini, 2008; Westhead, 1997; C. H. Yang et al., 2009)). The result from literature are unsurprisingly inconclusive. We argue that the performance result are unsurprisingly mix because in the sense that parks are heterogeneous and the bias of interest used measurement indicators (more detail about the variety of indicators see, Albahari, Catalano, & Landoni, 2013).

Overall, the implications of STPs are very broaden and include changes in the spatial distribution of economic activities and in the skill composition of the labour force, as well as gains in productivity (Arauzo-Carod, Segarra-Blasco, & Teruel, 2018). Besides, the literature approached on the parks performance have become much larger both in practitioners and academicians agenda. In this paper, performance refer to contribution of STPs to their tenants firms and region which, in many quantitative studies used an innovation outcome and regional economic growth as a proxy measurement.

### Why do regional contextual factors matter?

Literature in regional studies (Cooke, 1996; Gössling & Rutten, 2007; Romero-Martinez & Ortiz-de-Urbina-Criado, 2011; Wolfe, 2013) show that innovation and the dynamic of economic growth are geographically localised. Due to the factors that create new knowledge or the decision to start a new firm was influenced from an individual perspective and emerging from regional characteristics. This in lines with the study in regional entrepreneurship which shown that the new entrepreneurship activities are unevenly spread. They argue that regional characteristics can influence individual-level factors such as perceived skills to found a new venture or fear of failure preventing entrepreneurial activity (Audretsch & Lehmann, 2005; Stuetzer, Obschonka, Brixy, Sternberg, & Cantner, 2013).

We summarised the key importance of regional dimensions from literature (Autio & Klofsten, 1998; Cooke & Uranga, 1997; Rondé & Hussler, 2005; Todtling & Trippl, 2005) as below

1. Regions differ with the evolution through their *institutions* (e.g. political context, including policy competence, law, taxation and cultural).
2. *Network relations among regional actors* that create knowledge spillover, also the tacit knowledge transfer are spatial ground.(Todtling & Trippl, 2005; Wolfe, 2013).
3. *Industrial structure* and their specialisation pattern

*Institutions*

Lundvall (2007) argues that certain institutional arrangements are the important tool to promoting innovation. Formal institutions (as laws) and informal institutions (like cultural norms and values) shape and influence innovation output in region in different aspects. Moreover, it influences the extent and the way organisations coordinate their actions (Boschma & Frenken, 2010).

The Literature on cultural and innovation (Efrat, 2014; Shane, 1993; Tekin & Tekdogan, 2015) present that culture is matter in term of improving innovation capacity of society. Tekin & Tekdogan (2015) assess role of culture in determining the innovation capacity of a society. They found that the GDP level of the countries and their ranking in the index clearly verify that prevailing culture in the society is somehow matter in determining the innovational capacity of that society. In fact, the societies which have higher innovation capacities are characterized by higher individualism, willingness to take risks, readiness to accept change, long-term orientation, low on power/status/hierarchy (low power distance), weak uncertainty avoidance, openness to new information, frequent travel, positive attitude towards science, value of education to society, religion.

*Network relations among regional actors*

Wolfe, 2013 argue that the important of innovation analysis in regional level was linked to the important of network relations among actors in the innovation process and the tendency for those networks to be spatially grounded. The triple helix collaboration is the important approach that has been discussed in the fields of regional networks. The idea behind triple-helix approach is to encourage collaborative arrangements by providing an arena where firm, university and government agents meet and exchange knowledge, and there is an assumption that this will increase innovation in the area(Leydesdorff & Meyer, 2003). This approach highlight the main important of three actors in region; industry, university and government. It believes that the integration these three actors could maximise knowledge creation which in turn encourages the development of regional innovation (Junjie & Heng, 2013).

University is the input resources for innovation, in both R&D development (which, can lead to research spinoff) and human labour support. Firms raise their technological level, they need a knowledge sharing or training engagement from University. This network tie is observed strong when the research interested between University and local industries are matched(M. Yan, Chien, Hong, & Yang, 2018). In this case, STP can act as an intermediate role to accelerate the process.

*Industrial structure*

The industry structure of a region affects the overall new firm formation rates in a region, for example, there are firms emerge from business services but there are a few in mining industries (Bosma, Schutjens, & Stam, n.d.). Recently, there is an emergence of regional policy on smart specialisation which, integrate the view of localisation and related variety together. This policy encourages that local should build their competence create innovation base on their existing resources in region, the bottom-up process that link between local and central policy (Jurgen, Roman, & Schicketanz, 2014)

According to Foray (2018), specialisation should not be understood in a classical sense but rather reconcile with theories of Marshallian specialisation and Jacobian diversification theory. This idea links to extant EEG literature in terms of regional diversification. Regional diversification is defined as a branching process, in which new activities draw and combine related local activities (Boschma, Balland, & Kogler, 2015). In order to develop new distinctive areas of specialisation for the future, Boschma and Gianelle (2014) state that regional diversification is a crucial process. Besides, they state that some examples of case studies show that the long-term resilience of specific regions is depending on the reconfiguration and reorientation of existing regional assets. Research by Glaeser (2005), has comprehensively outlined on how Boston recreate itself by developing and reconfiguring its related skills from 1630 to 2003.

In sum, we believe that regions are diverse and evolve along their own characteristics influence by Institutions, local actors and industrial structure. Local Innovation is stimulated by the 'right' regional contextual framework.

## Methodology

To examine the relationship between regional contextual factors and the performance of STPs we conduct a systematic, exploratory literature review. Systematic reviews are used to improve the evidence-base of a field and its subfields through a process of synthesizing research in a systematic, transparent and reproducible manner (Tranfield, Denyer, & Smart, 2003). According to Tranfield et al. (Tranfield et al., 2003) a systematic review in management and social science studies should be initiated with a scoping study to assess the relevance and size of the literature as well as to delimit the focus of the review. Therefore the process of conducting the systematic review consisted of a rather long planning phase containing two elements: A scoping study of literature on related and relevant concepts, namely STPs, regional studies, evolutionary economic geography, smart specialisation policy etc. which identified the need for a review. And the development of a review protocol that reflects the conceptual discussion of the scoping study, the objective of the review and the significance of the problem.

A second step in the review process was to develop comprehensive, unbiased search parameters in order to identify relevant literature. We decided to identify the master sample of papers by using search parameters to

include papers on STPs and performance (see figure X for the precise search terms). Since we identified in the scoping study that the linkage between STPs and the regional context is a rather under investigated relation we decided to qualitatively assess whether a paper includes regional contextual factors or not, rather than trying to include this limitation of the sample through search parameters.

We limited our search to the Web of Science (WoS), using Social Science Citation Index (SSCI) and Science Citation Index (SCI) database for similar reasons as put forward by Mora-Valentin et al. (2018). We included only articles and reviews, and left out book chapters and conference proceedings. The whole search process is shown in figure 1. This search process identified a total number of 451 journal articles without any duplicates.

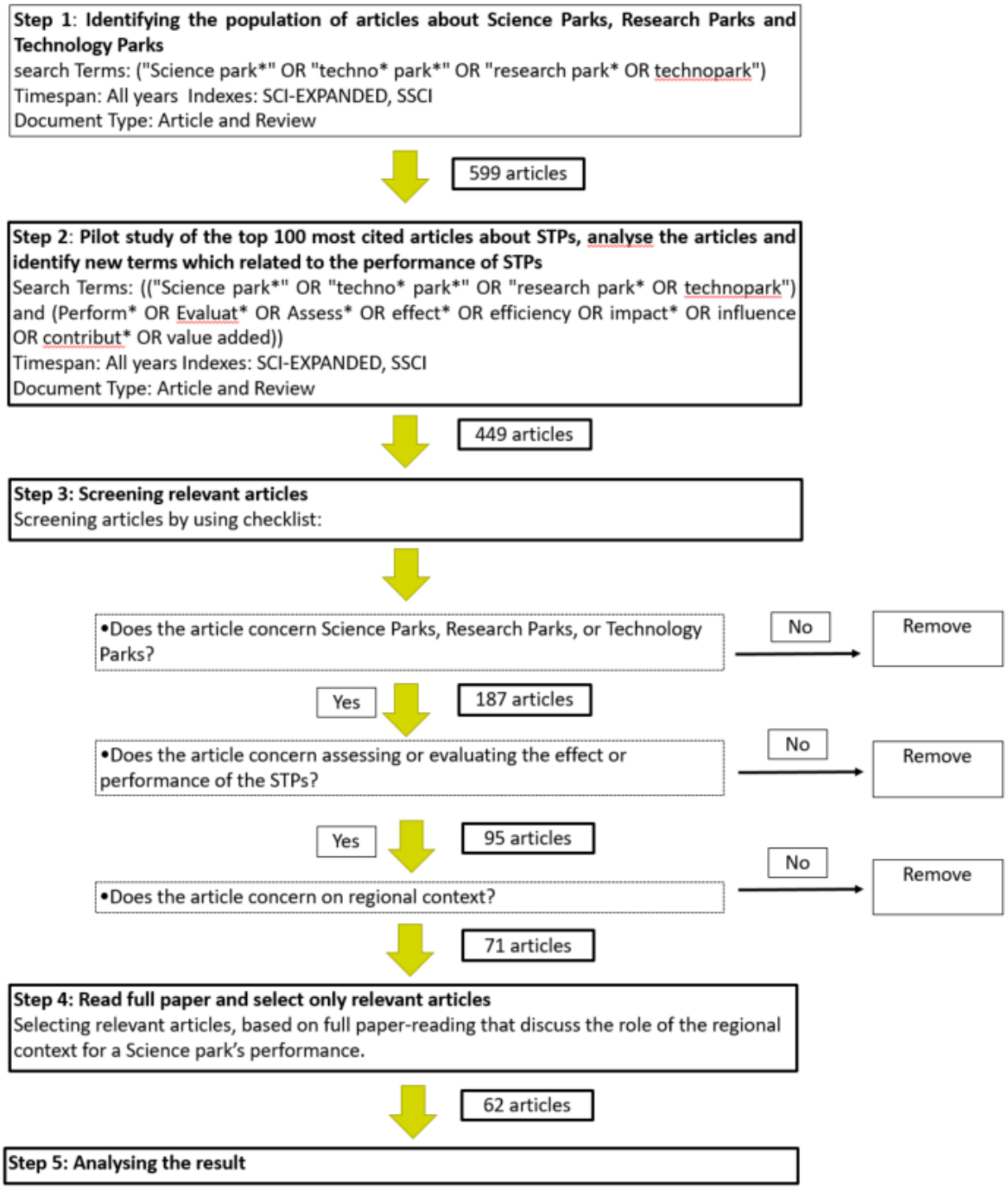


Fig. 1. Literature Search and selection process

As illustrated by figure 1, we first identified the population of articles on STPs by using the search terms ("Science park*" OR "techno* park*" OR "research park* OR technopark*). In Step 2, we identified the top 100 most cited articles in order to identify which terms are used in studies of STPs' performance. We found several search terms ((Perform* OR Evaluat* OR Assess* OR effect* OR efficiency OR impact* OR influence OR contribut* OR value added)) to be included in a second search in order to identify the population of journal articles that deal with STPs and performance.

Third, we reduced the population of articles by screening Title and Abstract using a three steps checklist (see figure 1). Through this process, we reduced the amount of articles to 71. In the subsequent full text reading of the articles a further nine studies were dropped, leaving the sample size of relevant articles to 62.

### Synthesis method

Since the aim of this study is to shed light on a relationship, which has not received pronounced attention in prior research, we follow an exploratory approach in the synthesis of the literature. We use thematic synthesis since most studies in our sample only relate partially to the regional context. Thematic synthesis is useful for understanding how different themes relate to a specific analytical unit and to handle contradictory findings on the relationship between concepts (Barnett-Page & Thomas, 2009). We follow an open-ended coding process where we initially code every finding that points to the importance of a regional contextual factor under a label suitable for the given factor. The codes are iteratively grouped into themes that captures the elements of the regional context, such as institutional settings, industrial structure, knowledge base or availability of finance. Concurrently, the findings on performance are coded for each paper to show whether a study find that the STP(s) have a positive or negative impact on the specific performance measure which the paper has focused on.

Subsequently we extracted reports that show how the different themes relates to the STPs' performance, the factors were group into seven categories. There are five regional related categories that we like to discuss in this paper: urbanisation, financial, University and HEI, Industrial structure and institutional, while the others two factors, intra-region network and parks internal factors are less relevant in this paper but we agree that apart from these endogenous regional factors, those two factors are also important to mention.

### Result

We present the result of positive and negative impacts of contextual factors that influence STPs' performance with the number of papers that discuss on relevant topics in the table below.

**Table 1**, Result summarisation on factors that influence STPs' performance

| Factors | Positive | Negative | Articles |
|---|---|---|---|
| **Urbanisation** | • Develop urbanisation region attracts firms investment and human labour accumulation. | • De-urbanisation struggles to attract technical staffs but urbanisation also have a problem with high population density, insufficient space for company expansion. | Edgington, 2008<br>Phelps & Dawood, 2014<br>Shin, 2000 |
| **Financial support** | • Accessible to venture capital is identified as crucial in order to start a new technology based firm. The available of funding support also influence the result of innovation outcome. | • Newer and smaller firms find it is difficult to obtain financial support and the lack of financial aid can hamper technology commercialisation. | McAdam & McAdam, 2008<br>Mukkala, 2010a<br>Löfsten & Lindelöf, 2003<br>Salvador & Rolfo, 2011<br>Watkins-Mathys & Foster, 2006<br>Xiao & North, 2018 |
| **Institutional**<br>• Innovation | • Favourable entrepreneur | • Weak innovation culture lead to the lack of trust | Edgington, 2008<br>Hu, 2008 |

| Factors | Positive | Negative | Articles |
|---|---|---|---|
| culture and norm | culture is the starting point for innovation creation and generates informal network that lead to knowledge changing or labour mobility creation. | and interaction between various components in innovation system. | Lee, Lin, & Hsi, 2017<br>Miao & Hall, 2014<br>Zeng, Xie, & Tam, 2010<br>Zou & Zhao, 2013 |
| **Institutional**<br>• Policy and government support | • Strong national STI policy support science Parks e.g. cluster promotion, triple helix collaboration, infrastructure, technical service and incentive R&D can influence to the positive STPs' performance.<br>• Bottom up policy approach and actively engagement by local government especially in the development phase of the park is highly mention to positive STPs' outcome | • Government bureaucracy and unstable political situation, the latter lead to discontinue policy<br>• Lack of input from local resource, lack of local integration<br>• Policy flaws<br>o No protection for intellectual property right<br>o Mismatch policy between central government and local Universities<br>o Over emphasise the infrastructure by ignoring the entrepreneur process<br>o Lack of innovation quality control | Albahari, Catalano, & Landoni, 201<br><br>Benneworth & Ratinho, 2014<br>Biswas, 2004<br>Brooker, 2013<br>Cheng, van Oort, Geertman, & Hooimeijer, 2014<br>Edgington, 2008<br>Gkypali, Kokkinos, Bouras, & Tsekouras, 2016<br>Hommen, Doloreux, & Larsson, 2006<br>Huang & Fernández-Maldonado, 2016<br>Jenkins & Leicht, 2018<br>Kennedy, 2007<br>H.-Y. Kim & Jung, 2010<br>H. Kim, Lee, & Hwang, 2014<br>Lee et al., 2017<br>Lin & Tzeng, 2009<br>Malairaja & Zawdie, 2008<br>Miao & Hall, 2014<br>Mukkala, 2010<br>Phelps & Dawood, 2014<br>Shin, 2000<br>Xiao & North, 2018<br>Yan & Chien, 2013<br>Yang, Hsu, & Ching, 2009<br>Zou & Zhao, 2013 |
| **Industrial Structure** | • Proper industrial clustering mechanism can further innovation | • Scatter industrial structure lead to the lack of core technology and R&D development. | Appold, 2004<br>Etzkowitz & Zhou, 2018 |

| Factors | Positive | Negative | Articles |
|---|---|---|---|
| | outcome and strengthen embedded network in region<br>• High degree of specialisation relates to the efficiencies of providing resources to tenant firms and could attract firms in the specific specialise field also overlap with knowledge interest<br>• Focus cluster could create a favourable innovation ecosystem by having a sufficient specialised labour pooling | • Region with no industry focus reflects the weak image of local University research competence<br>• Availability of a pool of potential tenants could be negative if the park narrow focus their specific specialise sector | Guadix, Carrillo-Castrillo, Onieva, & Navascués, 2016<br>Hansson, Husted, & Vestergaard, 2005<br>Hommen et al., 2006<br>Hu, 2008<br>Huang & Fernández-Maldonado, 2016<br>Jenkins & Leicht, 2018<br>Jonsson, 2002<br>Ku, Liau, & Hsing, 2005<br>Kulke, 2008<br>Lee et al., 2017<br>McCarthy, Silvestre, von Nordenflycht, & Breznitz, 2018<br>Miao & Hall, 2014<br>Minguillo & Thelwall, 2015a<br>Minguillo, Tijssen, & Thelwall, 2015<br>Mukkala, 2010<br>Padilla-Meléndez, Del Aguila-Obra, & Lockett, 2013<br>Park & Hu, 2011<br>Phelps & Dawood, 2014<br>Romijn & Albu, 2002<br>Shearmur & Doloreux, 2000<br>STAUDT, BOCK, & MUHLEMEYER, 1994<br>Tamásy, 2007<br>Tsai & Chang, 2016<br>Vásquez-Urriago, Barge-Gil, & Modrego Rico, 2016<br>M.-R. Yan & Chien, 2013<br>Yang et al., 2009<br>Yun & Lee, 2013<br>Zeng et al., 2010<br>Zou & Zhao, 2013 |

| Factors | Positive | Negative | Articles |
|---|---|---|---|
| **University, HEI, research institution and laboratory** | • Proximity nearby University have an impact on the success of STP, it increases the growth of network (informal connection with academic staffs and students)<br>• Universities were mentioned as a resource for human capital<br>• University policy should support innovation outcome e.g. encourage patent application and academic entrepreneur creation<br>• Matching research interested between HEI and local industries lead to positive linkage and R&D collaboration | • Lack of integration between HEIs and property and facilities offered at technology parks resulting in weaknesses in getting ideas to market or patent to product.<br>• Chance of knowledge transfer is low, if the level of research excellence is neglected.<br>• University research need to be integrate with local resources<br>• University view entrepreneur as a low status.<br>• Local universities cannot support qualified labour and scarcely provide the information about their research expertise | Albahari, Pérez-Canto, Barge-Gil, & Modrego, 2017<br>Appold, 2004<br>Bakouros, Mardas, & Varsakelis, 2002<br>Díez-Vial & Montoro-Sánchez, 2016<br>Etzkowitz & Zhou, 2018<br>Hansson et al., 2005<br>Hommen et al., 2006 Jongwanich, Kohpaiboon, & Yang, 2014<br>Jonsson, 2002<br>Kulke, 2008<br>Lee et al., 2017; Lin & Tzeng, 2009; Link & Scott, 2003;<br>Löfsten & Lindelöf, 2003; Malairaja & Zawdie, 2008; Minguillo & Thelwall, 2015b, 2015a;<br>Motohashi, 2013<br>Padilla-Meléndez et al., 2013 Park & Hu, 2011<br>Phelps & Dawood, 2014<br>Pilar Latorre, Hermoso, & Rubio, 2017<br>Ricardo Martínez-Cañas, 2011<br>Romijn & Albu, 2002<br>Shin, 2000<br>Watkins-Mathys & Foster, 2006 M. Yan, Chien, Hong, & Yang, 2018<br>Yun & Lee, 2013<br>Zou & Zhao, 2013 |

| Factors | Positive | Negative | Articles |
|---|---|---|---|
| **Additional factors** | | | |
| Intra-region connection | • Firms that have connection outside region have the opportunity in research activity, new knowledge creation, human labour development and wider market distribution. | • Lack of outside region connection means lack of market opportunity and result in the declination of start-up firms<br>• Lack of resources to upgrade cutting edge knowledge | Edgington, 2008<br>Jonsson, 2002<br>Koh, Koh, & Tschang, 2005<br>Ku et al., 2005<br>Löfsten & Lindelöf, 2003<br>Milius, 2008<br>Park & Hu, 2011<br>Watkins-Mathys & Foster, 2006<br>Yang et al., 2009<br>Yun & Lee, 2013 |
| Internal factors | • Park infrastructure and service that provide on what firms need<br>• Park management should have the ability to link industry and university, also others regional and national organisation that could support innovation | • Lack of management experience and not familiar with small firms in local area.<br>• Outdated infrastructure and inefficient administration system | Albahari et al., 2013<br>Bakouros et al., 2002<br>Lee et al., 2017<br>Malairaja & Zawdie, 2008<br>Milius, 2008<br>Minguillo & Thelwall, 2015b<br>Phelps & Dawood, 2014<br>STAUDT et al., 1994<br>Tamásy, 2007<br>Watkins-Mathys & Foster, 2006<br>Zou & Zhao, 2013 |

# Discussion

## Urbanisation

Urbanisation is a major factor that leads to thick product labour, real estate markets and provides many opportunities for human interaction (Bosma et al., n.d.). We found that Park that locates in city area have attracted human labour accumulation and new firms investment, while parks that locate in peripheral area had struggled to attracted staff as the case of KHTP in Malaysia (Phelps & Dawood, 2014) and the initial stage of Daeduck Science Park in Korea (Shin, 2000). However, the urban density also had a negative effect if they lack of well plan, space for firm expansion needs to be sufficient (Edgington, 2008).

## Financial Support

Clearly that the funding support influences the result of innovation outcome(Xiao & North, 2018).It plays a prominent role for firms in order to start their business or invest in their R&D activities (McAdam & McAdam, 2008; Mukkala, 2010b). McAdam & McAdam, (2008) argue that the role of STP not just only aiding to access the venture capital but including advice and guidance. The lack of venture capital can hamper technology commercialise process (Watkins-Mathys & Foster, 2006). Literature found that new firms have difficulties to obtain the financial support due to (1) the lack of financial resources information (Salvador, 2011), (2) the

uncertainty result about an entrepreneur's ability to start such a business and (3) the cost of financing for relatively small amounts can be extremely high because there are no economies of scale (Mukkala, 2010b).

### Institutions

There is a growing consensus that regional institutions play a significant role in promoting regional, economic development within the national and global context (Keune, 2001). The strong direction of national policy can push the positive outcome of innovation in different ways (Edgington, 2008; M. Yan et al., 2018; D. Y. R. Yang et al., 2009). (Albahari et al., 2013) compared two case studies between STP in Spain and Italy, they found that the Spanish SPS had a better result in terms of a number of firms hosted, employees and turnover. They argue that one of the results is the presence of a set of coherent and particular policies in favour of SPs in Spain, while the policies in Italy have had a discontinuous character.

Literature shown that parks expect the policy support in infrastructure investment, R&D centre, plan industrial technologies sharing community, project support new startup and also the support on networking (research, marketing) and innovation process(Lin & Tzeng, 2009; Mukkala, 2010b; Xiao & North, 2018). It is important to notice that, there are some literature provide the problematic of regional policy by point out that there is a lack of integration from local resources(Brooker, 2013; Gkypali et al., 2016; H. Kim et al., 2014; Shin, 2000) or mismatch policy between central government and the needed in region (Phelps & Dawood, 2014).

The review shows that the involvement of local authorities influences the performance of STPs. Strong commitment and actively involved from local government including the bottom up approach reflect the positive outcome for the park (Cheng et al., 2014; Hommen et al., 2006; Huang & Fernández-Maldonado, 2016; H.-Y. Kim & Jung, 2010; Zou & Zhao, 2013).(H. Kim et al., 2014). The study of Daedeok science park in South Korea presented that the number of firms had steadily increased after the state had the policy to encourage the regional government collaboration (H. Kim et al., 2014).

Favourable entrepreneur culture is the starting point for innovation creation and generates informal networks that lead to knowledge changing (informal network connection) or labour mobility creation (Edgington, 2008; Hu, 2008; Lee et al., 2017; Zou & Zhao, 2013). The weak of innovation culture reflects the lack of trust and collaboration in region(Miao & Hall, 2014; Zeng et al., 2010).

### University and HEI

Nauwelaers, Kleibrink, and Stancova (2014) argue that the presence or absence of a top level research institution or university is the core of STPs, and the strategies pursued by these institutions in terms of their third mission (service to society), influence the nature and depth of science- and research-driven relationships within STPs. The successful case of Majardevi science park in Sweden would be a good example that reflect the important of local university as a knowledge resources and human labour (Hommen et al., 2006). R&D institutions and HEI that create or participate in STPs expect to commercialise their research results, earn profits, and obtain feedback (Ricardo Martínez-Cañas, 2011). On the hand, firms that agglomerate on parks expect that they can access all resources of all faculties of the university in one location, if the synergies between park and university are fruitful (Jonsson, 2002).

Literature shows that the higher number of university collaboration reflects the higher number of patents. Firms with strong linkage with university has higher innovation output (product, service and patents) (Romijn & Albu, 2002). In term of patent, Albahari, Pérez-Canto, Barge-Gil, & Modrego, (2017) argue that the knowledge transferred is more scientific and analytical, and thus more suitable to be codified in patents when the involvement of universities within the park is higher. A formal relationship between park and university is important to enhanced research output (e.g., publications and patents), increased extramural funding, and improvements in hiring and placement capabilities (Link & Scott, 2003). Newcastle case, argue that the park act as a n active role to create entrepreneur culture with university (Hansson et al., 2005). There is a strong relationship between HEI quality and importance in the collaboration network. However, there is no significant difference between medium and low-quality HEIs (Minguillo & Thelwall, 2015a).

There is an evidence that the proximity between local universities, research institution and parks is matter. Appold, (2004) found that research parks appear more successful if at least some laboratories are already located nearby. Geographical proximity, as highlighted by Padilla-Meléndez, Del Aguila-Obra, & Lockett (2013), is an important issue regarding knowledge transfer and exchange for spin-off SMEs. Moreover, the spatial proximity has encouraged the growth of network (Kulke, 2008). This network could be both formal and informal interactions. Informal connection, are important for identifying the researcher's capabilities, accessing knowledge and informal connection with faculty members and access to students ( (Motohashi, 2013; Padilla-Meléndez et al., 2013).

The matching of research interested between academia-industry is one of the reasons that could influence R&D development or patent application. If the university has, the knowledge matches with the needs of private-sector businesses, then the collaboration from company in order to develop the knowledge would not be difficult (M. Yan et al., 2018) or it could strengthen the knowledge transfer between research producer and private sector (Minguillo & Thelwall, 2015a). This issue also mentioned by Malairaja & Zawdie, (2008) and Park & Hu, (2011).

There is an evidence that universities always have a problem to transform patent to innovation product (Albahari et al., 2017). In this case, park facilities should be integrated with HEI to offer their needed in order to reduce the difficulties of getting the ideas to market, (Phelps & Dawood, 2014). Moreover, the case of University of Newcastle science park shown that university viewed entrepreneur as a low status (Etzkowitz & Zhou, 2018). This could be the major problem that reflects the weak linkage between STP and university. The case of Symbion science park show similarity that student awareness of research commercialisation as a career option is rather low (Hansson et al., 2005). Besides, the student entrepreneur always has a problem with marketing and management skills. Watkins-Mathys & Foster, (2006) suggest that university need to consider introducing marketing and business course into the curriculum of their science and technology degree courses.

### Industrial structure

Yan et al., (2018) argue that a proper industrial clustering mechanism and innovation ecosystem can further facilitate the high-technology industries to reach the status of an upgraded economy. SPs may only be able to exploit the dynamism and competitiveness that already exist in a region—the so-called spontaneous clusters (Minguillo et al., 2015). This could be in line with the study from (Tsai & Chang, 2016), which mention that industrial cluster is the most significant factor that influences HSIP. The strong industrial clustering mechanism also reflects the strengthen embedded network in region (Ku et al., 2005; Yun & Lee, 2013). Local lead firms that locate on STP can act as anchor tenant, attracts the other firms in similar field. This mechanism might lead to the degree of specialised in the park, which related to the efficiencies of providing resources to tenant firms, they can invest in the similar resources that the firms in this specific field need. Moreover, focus cluster could create a favourable innovation ecosystem by having a sufficient specialised labour pooling. The scatter industrial structure lead to the lack of core technology and R&D development. Region with no industry focus reflects the weak image of local University research competence. Moreover, the availability of a pool of potential tenants could be negative if the park narrow focus their specific specialise sector.

### Intra-region collaboration and Park internal factors

Literature demonstrate that on park firms that have connections outside region have the opportunity in research activity, new knowledge creation, human labour development and wider market distribution(Edgington, 2008; Jonsson, 2002; Löfsten & Lindelöf, 2003; Milius, 2008; D. Y. R. Yang et al., 2009). On the contrary, lacking outside region connection means the lack of market opportunity and result in the declination of start-up firms(Koh et al., 2005).

From literature, we found that internal factors like STP infrastructure, service provided and manager management skills have an impact to STP operation. STP infrastructure and service should match with the firms needed (Milius, 2008; Zou & Zhao, 2013). Outdated infrastructure (Phelps & Dawood, 2014) and inefficient administration system (Zou & Zhao, 2013) hinder the effective operation. Moreover, park management should have the ability to link industry and university, also others organisation that could support innovation(Malairaja & Zawdie, 2008; Tamásy, 2007). The lack of management experience and less familiar with local firms imply to a negative performance(STAUDT et al., 1994; Watkins-Mathys & Foster, 2006).

## Conclusion

This study exploratory analysed 62 articles related to STPs' performance and regional context. The review of the literature indicates that the factors that influence park performance can be categorised into seven groups. Five of them are regional factors; urbanisation,financial support, institutions, industrial structure and university, the other two are additional factors outside the regional milieu; intra-region connection and STP internal factor. The review of literature presents that regional factors can influence STPs' performance in different aspects. We agree with Etzkowitz and Zhou (2018) that they use the metaphor of STP as an adaptable empty box that could be filled in a variety of ways. STP can be adjusted to achieve various objectives in accordance to local situations at different stage of development. This also in line with (Harper & Georghiou, 2005), they support that the development of STP is context driven, resource dependent and competence based. To make the best use of STP, it is important to integrate region capability in STP develop strategies. This leads to the question that how can STP integrate their strategies with regional circumstance. The result from the review will be used as a baseline for further empirical study in order to see the relation of STP and regional context.

## References


Albahari, A., Catalano, G., & Landoni, P. (2013). Evaluation of national science park systems: a theoretical framework and its application to the Italian and Spanish systems. *Technology Analysis and Strategic Management*, *25*(5), 599–614. https://doi.org/10.1080/09537325.2013.785508

Albahari, A., Pérez-Canto, S., Barge-Gil, A., & Modrego, A. (2017). Technology Parks versus Science Parks: Does the university make the difference? *Technological Forecasting and Social Change*, *116*, 13–28. https://doi.org/10.1016/j.techfore.2016.11.012

Albahari, A., Pérez-Canto, S., & Landoni, P. (2010). Science and Technology Parks impacts on tenant organisations: a review of literature. *MPRA Paper*, (41914), 29.

Amirahmadi, H., & Saff, G. (1993). Science Parks: A Critical Assessment. *Journal of Planning Literature*, *8*(2), 107–123. https://doi.org/10.1177/088541229300800201

Appold, S. J. (2004). Research parks and the location of industrial research laboratories: An analysis of the effectiveness of a policy intervention. *Research Policy*, *33*(2), 225–243. https://doi.org/10.1016/S0048-7333(03)00124-0

Arauzo-Carod, J. M., Segarra-Blasco, A., & Teruel, M. (2018). The role of science and technology parks as firm growth boosters: an empirical analysis in Catalonia. *Regional Studies*, *52*(5), 645–658. https://doi.org/10.1080/00343404.2018.1447098

Audretsch, D. B., & Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy*, *34*(8), 1191–1202. https://doi.org/10.1016/j.respol.2005.03.012

Autio, E., & Klofsten, M. (1998). A comparative study of two European business incubators. *Journal of Small Business Management (Print)*, *36*(1), 30–43. https://doi.org/10.1023/a:1007941801303

Bakouros, Y. L., Mardas, D. C., & Varsakelis, N. C. (2002). Science park , a high tech fantasy ?: an analysis of the science parks of Greece, *22*, 123–128.

Barnett-Page, E., & Thomas, J. (2009). Methods for the synthesis of qualitative research: A critical review. *BMC Medical Research Methodology*, *9*(1). https://doi.org/10.1186/1471-2288-9-59

Benneworth, P., & Ratinho, T. (2014). Reframing the role of knowledge parks and science cities in knowledge-based urban development. *Environment and Planning C: Government and Policy*, *32*(5), 784–808. https://doi.org/10.1068/c1266r

Bigliardi, B., Dormio, A. I., Nosella, A., & Petroni, G. (2006). Assessing science parks' performances: Directions from selected Italian case studies. *Technovation*, *26*(4), 489–505. https://doi.org/10.1016/j.technovation.2005.01.002

Biswas, R. R. (2004). Making a technopolis in Hyderabad, India: The role of government IT policy. *Technological Forecasting and Social Change*, *71*(8 SPEC. ISS.), 823–835.

https://doi.org/10.1016/j.techfore.2004.01.009

Boschma, R., Balland, P. A., & Kogler, D. F. (2015). Relatedness and technological change in cities: The rise and fall of technological knowledge in US metropolitan areas from 1981 to 2010. *Industrial and Corporate Change*, *24*(1), 223–250. https://doi.org/10.1093/icc/dtu012

Boschma, R., & Frenken, K. (2010). The spatial evolution of innovation networks. A proximity perspective. *The Handbook of Evolutionary Economic Geography*, 120–135. https://doi.org/10.1111/j.1468-2257.2011.00560.x

Boschma, R., & Gianelle, C. (2014). Regional Branching and Smart Specialisation Policy. *S3 Policy Brief Series*, (06). https://doi.org/10.2791/65062

Bosma, N., Schutjens, V., & Stam, E. (n.d.). Regional entrepreneurship. In *Handbook of Regional innovation and growth* (pp. 428–494). Edward Elgar Publishing Limited.

Brooker, D. (2013). From ' wannabe ' Silicon Valley to global back office ? Examining the socio-spatial consequences of technopole planning practices in Malaysia, *54*(1), 1–14. https://doi.org/10.1111/apv.12001

Cabral, R., & Dahab, S. S. (1998). Science parks in developing countries: the case of BIORIO in Brazil. *International Journal of Technology Management*, *16*(8), 726. https://doi.org/10.1504/IJTM.1998.002693

Cheng, F., van Oort, F., Geertman, S., & Hooimeijer, P. (2014). Science Parks and the Co-location of High-tech Small- and Medium-sized Firms in China's Shenzhen. *Urban Studies*, *51*(5), 1073–1089. https://doi.org/10.1177/0042098013493020

Colombo, M. G., & Delmastro, M. (2002). How effective are technology incubators? *Research Policy*, *31*(7), 1103–1122. https://doi.org/10.1016/S0048-7333(01)00178-0

Cooke, P. (1996). The new wave of regional innovation networks: Analysis, characteristics and strategy. *Small Business Economics*, *8*(2), 159–171. https://doi.org/10.1007/BF00394424

Cooke, P., & Uranga, M. G. (1997). dimensions, *26*, 475–491.

Diez-Vial, I., & Fernández-Olmos, M. (2017). The effect of science and technology parks on a firm's performance: a dynamic approach over time. *Journal of Evolutionary Economics*, *27*(3), 413–434. https://doi.org/10.1007/s00191-016-0481-5

Díez-Vial, I., & Montoro-Sánchez, Á. (2016). How knowledge links with universities may foster innovation: The case of a science park. *Technovation*, *50–51*, 41–52. https://doi.org/10.1016/j.technovation.2015.09.001

Edgington, D. W. (2008). The Kyoto Research Park and Innovation in Japanese Cities. *Urban Geography*, *29*(5), 411–450. https://doi.org/10.2747/0272-3638.29.5.411

Efrat, K. (2014). The direct and indirect impact of culture on innovation. *Technovation*, *34*(1), 12–20. https://doi.org/10.1016/j.technovation.2013.08.003

Etzkowitz, H., & Zhou, C. (2018). Innovation incommensurability and the science park. *R and D Management*, *48*(1), 73–87. https://doi.org/10.1111/radm.12266

Ferguson, R. (2004). Why firms on science parks should not be expected to show better performance the story of twelve biotechnology firms. *International Journal of Technology Management*, *28*(3/4/5/6), 470. https://doi.org/10.1504/IJTM.2004.005305

Foray, D. (2018). SPECIALISATIONx Designing a Smart Specialisation Strategy.

Fukugawa, N. (2006). Science parks in Japan and their value-added contributions to new technology-based firms. *International Journal of Industrial Organization*, *24*(2), 381–400. https://doi.org/10.1016/j.ijindorg.2005.07.005

Gkypali, A., Kokkinos, V., Bouras, C., & Tsekouras, K. (2016). Science parks and regional innovation performance in fiscal austerity era: Less is more? *Small Business Economics*, *47*(2), 313–330.

https://doi.org/10.1007/s11187-016-9717-x

Glaeser, E. L. (2005). Reinventing Boston: 1630-2003. *Journal of Economic Geography*, *5*(2), 119–153. https://doi.org/10.1093/jnlecg/lbh058

Goldstein, H. A., & Luger, M. I. (1990). Science/Technology Parks and regional Development Theory. Sage Social Science Collections.

Gössling, T., & Rutten, R. (2007). Innovation in regions. *European Planning Studies*, *15*(2), 253–270. https://doi.org/10.1080/09654310601078788

Guadix, J., Carrillo-Castrillo, J., Onieva, L., & Navascués, J. (2016). Success variables in science and technology parks. *Journal of Business Research*, *69*(11), 4870–4875. https://doi.org/10.1016/j.jbusres.2016.04.045

Hansson, F., Husted, K., & Vestergaard, J. (2005). Second generation science parks: From structural holes jockeys to social capital catalysts of the knowledge society. *Technovation*, *25*(9), 1039–1049. https://doi.org/10.1016/j.technovation.2004.03.003

Harper, J. C., & Georghiou, L. (2005). Foresight in innovation policy: Shared visions for a science park and business-University links in a city region. *Technology Analysis and Strategic Management*, *17*(2), 147–160. https://doi.org/10.1080/09537320500088716

Henriques, I. C., Sobreiro, V. A., & Kimura, H. (2018). Science and technology park: Future challenges. *Technology in Society*, *53*, 144–160. https://doi.org/10.1016/j.techsoc.2018.01.009

Hobbs, K. G., Link, A. N., & Scott, J. T. (2017). Science and technology parks: an annotated and analytical literature review. *Journal of Technology Transfer*, *42*(4), 957–976. https://doi.org/10.1007/s10961-016-9522-3

Hommen, L., Doloreux, D., & Larsson, E. (2006). Emergence and growth of Mjärdevi Science Park in Linköping, Sweden. *European Planning Studies*, *14*(10), 1331–1361. https://doi.org/10.1080/09654310600852555

Hu, T. S. (2008). Interaction among high-tech talent and its impact on innovation performance: A comparison of Taiwanese science parks at different stages of development. *European Planning Studies*, *16*(2), 163–187. https://doi.org/10.1080/09654310701814462

Huang, W. J., & Fernández-Maldonado, A. M. (2016). High-tech development and spatial planning: comparing the Netherlands and Taiwan from an institutional perspective. *European Planning Studies*, *24*(9), 1662–1683. https://doi.org/10.1080/09654313.2016.1187717

Jenkins, J. C., & Leicht, K. T. (2018). Do High Technology Policies Work ? High Technology Industry Employment Growth in U . S . Metropolitan Areas , 1988-1998 Differing Views on Location-specific Technology Policies, *85*(1), 1988–1998.

Jongwanich, J., Kohpaiboon, A., & Yang, C. H. (2014). Science park, triple helix, and regional innovative capacity: Province-level evidence from China. *Journal of the Asia Pacific Economy*, *19*(2), 333–352. https://doi.org/10.1080/13547860.2014.880285

Jonsson, O. (2002). Innovation processes and proximity: The case of IDEON firms in Lund, Sweden. *European Planning Studies*, *10*(6), 705–722. https://doi.org/10.1080/0965431022000003771

Junjie, Z., & Heng, L. (2013). The Effects of the University Science Park on Urban Development in, *689*(2003), 417–421. https://doi.org/10.4028/www.scientific.net/AMR.689.417

Jurgen, B. F., Roman, H. H., & Schicketanz, J. (2014). Triple helix and residential development in a science and technology park: the role of intermediaries Introduction and research question, 1–14. https://doi.org/10.1186/s40604-014-0010-1

Kennedy, L. (2007). Regional industrial policies driving peri-urban dynamics in Hyderabad, India. *Cities*, *24*(2), 95–109. https://doi.org/10.1016/j.cities.2006.06.001

Kim, H.-Y., & Jung, C. M. (2010). Does a Technology Incubator Work in the Regional Economy? Evidence from South Korea. *Journal of Urban Planning and Development*, *136*(3), 273–284. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000019

Kim, H., Lee, Y. S., & Hwang, H. R. (2014). Regionalization of planned S&T parks: The case of Daedeok S&T park in Daejeon, South Korea. *Environment and Planning C: Government and Policy*, *32*(5), 843–862. https://doi.org/10.1068/c1269r

Koh, F. C. C., Koh, W. T. H., & Tschang, F. T. (2005). An analytical framework for science parks and technology districts with an application to Singapore. *Journal of Business Venturing*, *20*(2), 217–239. https://doi.org/10.1016/j.jbusvent.2003.12.002

Ku, Y. L., Liau, S., & Hsing, W. (2005). The high-tech milieu and innovation-oriented development, *25*, 145–153. https://doi.org/10.1016/S0166-4972(03)00074-9

Kulke, E. (2008). The technology park Berlin-Adlershof as an example of spatial proximity in regional economic policy. *Zeitschrift Fur Wirtschaftsgeographie*, *52*(4), 193–208.

Lamperti, F., Mavilia, R., & Castellini, S. (2015). The role of Science Parks: a puzzle of growth, innovation and R&D investments. *Journal of Technology Transfer*, *42*(1), 158–183. https://doi.org/10.1007/s10961-015-9455-2

Lee, S. J., Lin, G. T. R., & Hsi, P. H. (2017). Industrial Cluster Development and its Contribution to Economic Growth in Taiwan - Hsinchu Science and Industrial Park (HSIP). *Journal of Scientific & Industrial Research*, *76*(5), 273–278.

Leydesdorff, L., & Meyer, M. (2003). The Triple Helix of university-industry-government relations. *Scientometrics*, *58*(2), 191–203. https://doi.org/10.1023/A:1026276308287

Lin, C. L., & Tzeng, G. H. (2009). A value-created system of science (technology) park by using DEMATEL. *Expert Systems with Applications*, *36*(6), 9683–9697. https://doi.org/10.1016/j.eswa.2008.11.040

Lindelöf, P., & Löfsten, H. (2002). Growth, management and financing of new technology-based firms-assessing value-added contributions of firms located on and off Science Parks. *Omega*, *30*(3), 143–154. https://doi.org/10.1016/S0305-0483(02)00023-3

Lindelöf, P., & Löfsten, H. (2003). Science Park Location and New Technology-Based Firms in Sweden - Implications for Strategy and Performance. *Small Business Economics*, *20*(3), 245–258. https://doi.org/10.1023/A:1022861823493

Lindelöf, P., & Löfsten, H. (2004). Proximity as a Resource Base for Competitive Advantage: University–Industry Links for Technology Transfer. *The Journal of Technology Transfer*, *29*(3/4), 311–326. https://doi.org/10.1023/B:JOTT.0000034125.29979.ae

Link, A. N., & Scott, J. T. (2003). US science parks: the diffusion of an innovation and its effects on the academic mission of universities. *International Journal of Industrial Organization*, *21*, 1323–1356. https://doi.org/10.1016/S0167-7187(03)00085-7

Lofsten, H., & Lindelof, P. (2001). Science parks in Sweden - industrial renewal and development? *R and D Management*, *31*(3), 309–322. https://doi.org/10.1111/1467-9310.00219

Lofsten, H., & Lindelöf, P. (2002). Science Parks and the growth of new technology-based firms—academic-industry links, innovation and markets. *Omega*, *30*(3), 143–154. https://doi.org/10.1016/S0305-0483(02)00023-3

Löfsten, H., & Lindelöf, P. (2003). Determinants for an entrepreneurial milieu: Science Parks and business policy in growing firms. *Technovation*, *23*(1), 51–64. https://doi.org/10.1016/S0166-4972(01)00086-4

Lundvall, B. Å. (2007). National innovation systems - Analytical concept and development tool. *Industry and Innovation*, *14*(1), 95–119. https://doi.org/10.1080/13662710601130863

Malairaja, C., & Zawdie, G. (2008). Science parks and university-industry collaboration in Malaysia. *Technology Analysis and Strategic Management*, *20*(6), 727–739. https://doi.org/10.1080/09537320802426432

Martínez-Cañas, R., Sáez-Martínez, F. J., & Ruiz-Palomino, P. (2012). Knowledge acquisition's mediation of social capital-firm innovation. *Journal of Knowledge Management*, *16*(1), 61–76. https://doi.org/10.1108/13673271211198945

McAdam, M., & McAdam, R. (2008). High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation*, *28*(5), 277–290. https://doi.org/10.1016/j.technovation.2007.07.012

McCarthy, I. P., Silvestre, B. S., von Nordenflycht, A., & Breznitz, S. M. (2018). A typology of university research park strategies: What parks do and why it matters. *Journal of Engineering and Technology Management - JET-M*, *47*(August 2015), 110–122. https://doi.org/10.1016/j.jengtecman.2018.01.004

Miao, J. T., & Hall, P. (2014). Optical illusion? The growth and development of the optics valley of China. *Environment and Planning C: Government and Policy*, *32*(5), 863–879. https://doi.org/10.1068/c1270r

Milius, P. B. (2008). Ten Years In The System of Entrepreneurship Stimulation. *Inzinerine Ekonomika-Engineering Economics*, *4*(4), 42–45.

Minguillo, D., & Thelwall, M. (2015a). Research excellence and university-industry collaboration in UK science parks. *Research Evaluation*, *24*(2), 181–196. https://doi.org/10.1093/reseval/rvu032

Minguillo, D., & Thelwall, M. (2015b). Which are the best innovation support infrastructures for universities? Evidence from r&d output and commercial activities. *Scientometrics*, *102*(1), 1057–1081. https://doi.org/10.1007/s11192-014-1458-5

Minguillo, D., Tijssen, R., & Thelwall, M. (2015). Do science parks promote research and technology? A scientometric analysis of the UK. *Scientometrics*, *102*(1), 701–725. https://doi.org/10.1007/s11192-014-1435-z

Mora-Valentín, E. M., Ortiz-de-Urbina-Criado, M., & Nájera-Sánchez, J. J. (2018). Mapping the conceptual structure of science and technology parks. *Journal of Technology Transfer*, 1–26. https://doi.org/10.1007/s10961-018-9654-8

Motohashi, K. (2013). The role of the science park in innovation performance of start-up firms: an empirical analysis of Tsinghua Science Park in Beijing. *Asia Pacific Business Review*. Taylor & Francis. https://doi.org/10.1080/13602381.2012.673841

Mukkala, K. (2010a). The Role of Regional Policies in Promoting Networking and Innovative Activity : Evidence from Small Finnish High-tech Firms The Role of Regional Policies in Promoting Networking and Innovative Activity : Evidence from Small Finnish High-tech Firms, *4313*. https://doi.org/10.1080/09654311003744175

Mukkala, K. (2010b). The role of regional policies in promoting networking and innovative activity: Evidence from small Finnish high-tech firms. *European Planning Studies*, *18*(7), 1057–1076. https://doi.org/10.1080/09654311003744175

Nahm, K. B. (2000). The evolution of science parks and metropolitan development. *International Journal of Urban Sciences*, *4*(1), 81–95. https://doi.org/10.1080/12265934.2000.9693465

Nauwelaers, C., Kleibrink, A., & Stancova, K. (2014). The Role of Science Parks in Smart Specialisation Strategies, (08). https://doi.org/10.2791/8851

Padilla-Meléndez, A., Del Aguila-Obra, A. R., & Lockett, N. (2013). Shifting sands: Regional perspectives on the role of social capital in supporting open innovation through knowledge transfer and exchange with small and medium-sized enterprises. *International Small Business Journal*, *31*(3), 296–318. https://doi.org/10.1177/0266242612467659

Park, S., & Hu, M. (2011). Evolution of knowledge creation and diffusion : the revisit, 949–977. https://doi.org/10.1007/s11192-011-0427-5

Pascoal, A., & Cabrita, M. do R. (2016). Innovation ecosystems centred in EU-based science parks: recent past and new trends Alcino. *Proceedings of the 4Th International Conference on Innovation and Entrepreneurship (Icie 2016)*, 367–373. Retrieved from https://www.researchgate.net/publication/303481041_Innovation_ecosystems_centred_in_EU-based_science_parks_recent_past_and_new_trends

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations, synthesis and future

research. *Journal of Business Venturing*, *20*(2), 165–182. https://doi.org/10.1016/j.jbusvent.2003.12.001

Phelps, N. A., & Dawood, S. R. S. (2014). Untangling the spaces of high technology in Malaysia. *Environment and Planning C: Government and Policy*, *32*(5), 896–915. https://doi.org/10.1068/c1272r

Pilar Latorre, M., Hermoso, R., & Rubio, M. A. (2017). A novel network-based analysis to measure efficiency in science and technology parks: the ISA framework approach. *Journal of Technology Transfer*, *42*(6), 1255–1275. https://doi.org/10.1007/s10961-017-9585-9

Quintas, P., Wield, D., & Massey, D. (1992). Academic-industry links and innovation: questioning the science park model. *Technovation*, *12*(3), 161–175. https://doi.org/10.1016/0166-4972(92)90033-E

Ricardo Martínez-Cañas. (2011). A literature review of the effect of science and technology parks on firm performance: A new model of value creation through social capital. *African Journal of Business Management*, *5*(30). https://doi.org/10.5897/AJBM11.768

Romero-Martinez, A. M., & Ortiz-de-Urbina-Criado, M. (2011). The role of regional location in innovativeness. *International Journal of Technology Management*, *54*(1), 94–115. https://doi.org/10.1504/IJTM.2011.038831

Romijn, H., & Albu, M. (2002). Innovation, networking and proximity: Lessons from small high technology firms in the UK. *Regional Studies*, *36*(1), 81–86. https://doi.org/10.1080/00343400120099889

Rondé, P., & Hussler, C. (2005). Innovation in regions: What does really matter? *Research Policy*, *34*(8), 1150–1172. https://doi.org/10.1016/j.respol.2005.03.011

Salvador, E. (2011). Are science parks and incubators good "brand names" for spin-offs? The case study of Turin. *Journal of Technology Transfer*, *36*(2), 203–232. https://doi.org/10.1007/s10961-010-9152-0

Salvador, E., & Rolfo, S. (2011). Are incubators and science parks effective for research spin-offs? Evidence from Italy. *Science and Public Policy*, *38*(3), 170–184. https://doi.org/10.3152/016502611X12849792159191

Shane, S. (1993). Cultural influences on national rates of innovation. *Journal of Business Venturing*, *8*(1), 59–73. https://doi.org/10.1016/0883-9026(93)90011-S

Shearmur, R., & Doloreux, D. (2000). Science parks: Actors or reactors? Canadian science parks in their urban context. *Environment and Planning A*, *32*(6), 1065–1082. https://doi.org/10.1068/a32126

Shin, D.-H. (2000). An alternative approach to developing science parks: A case study from Korea. *Regional Science*, *5*, 103–111. https://doi.org/10.5018/economics-ejournal.ja.2011-6.

Siegel, D. S., Westhead, P., & Wright, M. (2003). Science Parks and the Performance of New Technology-Based Firms : A Review of Recent U . K . Evidence and an Agenda for Future Research. *Small Business Economics*, *20*, 177–184. https://doi.org/10.1023/A:1022268100133

Squicciarini, M. (2008). Science Parks' tenants versus out-of-Park firms: Who innovates more? A duration model. *Journal of Technology Transfer*, *33*(1), 45–71. https://doi.org/10.1007/s10961-007-9037-z

Squicciarini, M. (2009). Science parks, knowledge spillovers, and Firms' innovative performance. Evidence from Finland. *Economics: The Open-Access, Open-Assessment E-Journal*, *32*, 0–29. Retrieved from http://www.economics-ejournal.org/economics/discussionpapers/2009-32%5CnScience

STAUDT, E., BOCK, J., & MUHLEMEYER, P. (1994). Technology Centers and Science Parks - Agents or Competence Centers for Small Businesses. *International Journal of Technology Management*, *9*(2), 196–212.

Stuetzer, M., Obschonka, M., Brixy, U., Sternberg, R., & Cantner, U. (2013). Regional characteristics, opportunity perception and entrepreneurial activities. *Small Business Economics*, *42*(2), 221–244. https://doi.org/10.1007/s11187-013-9488-6

Tamásy, C. (2007). Rethinking technology-oriented business incubators: Developing a robust policy instrument for entrepreneurship, innovation, and regional development? *Growth and Change*, *38*(3), 460–473. https://doi.org/10.1111/j.1468-2257.2007.00379.x

Tekin, H., & Tekdogan, O. F. (2015). Socio-Cultural Dimension of Innovation. *Procedia - Social and Behavioral Sciences*, *195*, 1417–1424. https://doi.org/10.1016/j.sbspro.2015.06.438

Todtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research Policy*, *34*(8), 1203–1219. https://doi.org/10.1016/j.respol.2005.01.018

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review *. *British Journal of Management*, *14*, 207–222. https://doi.org/10.1111/1467-8551.00375

Tsai, C.-L., & Chang, H.-C. (2016). Evaluation of critical factors for the regional innovation system within the HsinChu science-based park. *Kybernetes*, *45*(4), 699–716. https://doi.org/10.1108/K-02-2015-0059

Tsamis, A. (2009). Science and Technology Parks in the less favoured regions of Europe : an evaluation of their performance and the parameters of success, 460. Retrieved from http://etheses.lse.ac.uk/id/eprint/2543

UNESCO. (2017). Science Policy and Capacity-Building. Retrieved December 4, 2017, from http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/

Vásquez-Urriago, Á. R., Barge-Gil, A., & Modrego Rico, A. (2016). Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain. *Research Policy*, *45*(1), 137–147. https://doi.org/10.1016/j.respol.2015.07.006

Watkins-Mathys, L., & Foster, M. J. (2006). Entrepreneurship: The missing ingredient in China's STIPs? *Entrepreneurship and Regional Development*, *18*(3), 249–274. https://doi.org/10.1080/08985620600593161

Westhead, P. (1997). R&D "inputs" and "outputs" of technology-based firms located on and off science parks. *R&D Management*, *27*(1), 45–62. https://doi.org/10.1111/1467-9310.00041

Wolfe, D. A. (2013). Neo-Schumpeterian perspectives on innovation and growth. In P. Cooke, B. Asheim, R. Boschma, R. Martin, D. Schwartz, & F. Todtling (Eds.), *Handbook of Regional innovation and growth* (Paperback, pp. 48–49). Edward Elgar.

Xiao, L., & North, D. (2018). The role of Technological Business Incubators in supporting business innovation in China: a case of regional adaptability? *Entrepreneurship and Regional Development*, *30*(1–2), 29–57. https://doi.org/10.1080/08985626.2017.1364789

Yan, M.-R., & Chien, K.-M. (2013). Evaluating the Economic Performance of High-Technology Industry and Energy Efficiency: A Case Study of Science Parks in Taiwan. *Energies*, *6*(2), 973–987. https://doi.org/10.3390/en6020973

Yan, M., Chien, K., Hong, L., & Yang, T. (2018). Evaluating the Collaborative Ecosystem for an Innovation-Driven Economy : A Systems Analysis and Case Study of Science Parks. https://doi.org/10.3390/su10030887

Yang, C. H., Motohashi, K., & Chen, J. R. (2009). Are new technology-based firms located on science parks really more innovative?. Evidence from Taiwan. *Research Policy*, *38*(1), 77–85. https://doi.org/10.1016/j.respol.2008.09.001

Yang, D. Y. R., Hsu, J. Y., & Ching, C. H. (2009). Revisiting the silicon Island? The geographically varied "Strategic Coupling" in the development of high-technology parks in Taiwan. *Regional Studies*, *43*(3), 369–384. https://doi.org/10.1080/00343400902777067

Yun, S., & Lee, J. (2013). An innovation network analysis of science clusters in South Korea and Taiwan. *Asian Journal of Technology Innovation*, *21*(2), 277–289. https://doi.org/10.1080/19761597.2013.866310

Zeng, S., Xie, X., & Tam, C. (2010). Evaluating innovation capabilities for science parks: A system model. *Technological and Economic Development of Economy*, *16*(3), 397–413. https://doi.org/10.3846/tede.2010.25

Zou, Y., & Zhao, W. (2013). Anatomy of Tsinghua University science park in China: Institutional evolution and

assessment. *Journal of Technology Transfer*, *39*(5), 663–674. https://doi.org/10.1007/s10961-013-9314-y